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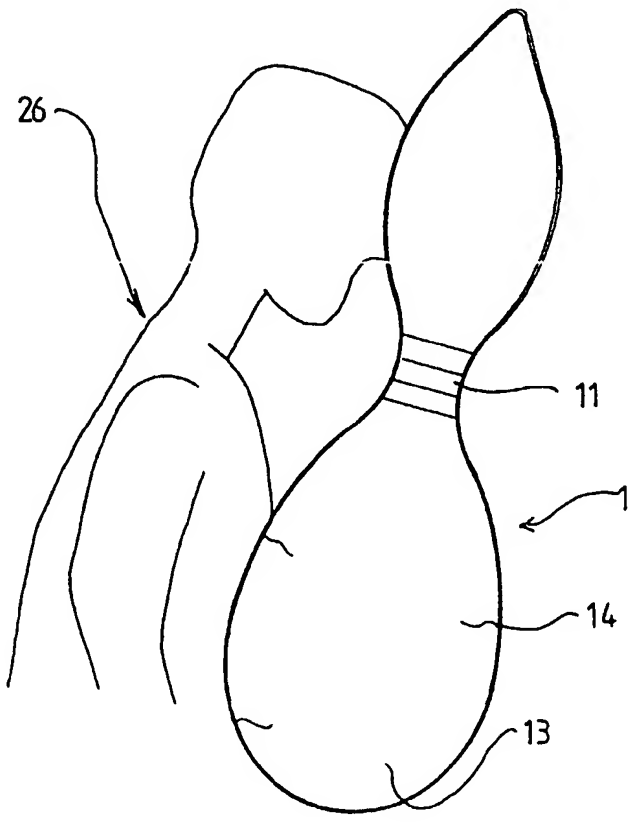
[Continued on next page]

(54) Title: AN AIR-BAG AND A METHOD OF DEPLOYING AN AIR-BAG



(57) Abstract: An air-bag (1) in a motor vehicle is releasably mounted to the vehicle by releasable mounting means (5) which initially connect part of the air-bag to the vehicle but which, in predetermined circumstances during inflation of the air-bag, are released, so that the air-bag is then disconnected from the vehicle. At least one gas-flow duct extends from the inflator arrangement for the air-bag to the interior of the air-bag through an aperture formed in the air-bag. The duct is adapted to be completely withdrawn from the air-bag in response to movement of the air-bag so that the air-bag becomes totally disconnected from the vehicle.

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PATENT COOPERATION TREATY

PCT

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference SP 08378 WO	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/SE 03/00626	International filing date *(day/month/year)* 17 April 2003	(Earliest) Priority Date *(day/month/year)* 1 May 2002
Applicant Autoliv Development AB et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readable form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. [ ] Certain claims were found unsearchable (See Box I).

3. [ ] Unity of invention is lacking (See Box II).

4. With regard to the title,

   [ ] the text is approved as submitted by the applicant.

   [X] the text has been established by this Authority to read as follows:

   An air-bag and a method of deploying an air-bag.

5. With regard to the abstract,

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No. 7

   [X] as suggested by the applicant. [ ] None of the figures.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

An air-bag and a method of deploying an air-bag.

THE PRESENT INVENTION relates to an air-bag and more particularly relates to an air-bag intended to be mounted in a motor vehicle and adapted to move to a position in front of an occupant of the vehicle when an accident occurs.

Whilst it is convenient to provide an air-bag which is mounted in a motor vehicle, with the intention that the air-bag will, on inflation thereof, move to a position in front of an occupant of the vehicle, difficulties can arise with such air-bags, especially if the air-bag is an overhead air-bag mounted, for example, in the roof of the vehicle, since there is a risk that as the torso and head of the occupant of the vehicle to be protected by the air-bag moves forwardly during an impact situation, the air-bag itself may impart an undesirable force to the head of the occupant, thus forcing the head backwards relative to the torso and causing neck injuries.

The present invention seeks to provide an improved air-bag arrangement.

According to this invention there is provided an air-bag in a motor vehicle, the air-bag being releasably mounted to the vehicle by means of a releasable mounting which initially connects part of the air-bag to the vehicle

but which, in predetermined circumstances, is released so that the air-bag is disconnected from the vehicle, the air-bag being associated with an inflator arrangement, there being at least one gas flow duct for gas from the inflator arrangement, the or each gas flow duct extending from the exterior of the air-bag to the interior of the air-bag through a respective aperture formed in the air-bag, and having a free end within the air-bag, the or each duct being adapted to be completely withdrawn from the air-bag in response to a movement of the air-bag after the releasable mounting means have disconnected the air-bag from the vehicle so that the air-bag becomes totally disconnected from the vehicle.

Preferably the or each aperture is provided with a valve to at least partially seal the aperture when the duct is withdrawn from the air-bag.

Conveniently a central part of the air-bag is provided with stitching or strapping in order to minimise the dimension of that part of the air-bag on inflation thereof.

Preferably the inflator arrangement is adapted to provide a relatively low flow rate of gas during an initial stage of inflation of the air-bag, and a higher flow rate of gas during a subsequent stage of inflation of the air-bag.

Conveniently the releasable mounting means are adapted to be released in response to inflation of the air-bag.

Preferably the releasable mounting means are adapted to be released when a predetermined pressure is present within the air-bag.

Conveniently the air-bag is an overhead bag, which may be mounted in the roof of the vehicle.

Advantageously part of the air-bag which is to form the lower-most part of the air-bag on deployment thereof is provided with at least one lower tear-seam or strap adapted to initially restrict the degree of inflation of the lower part of the air-bag, and adapted to break during inflation of the air-bag.

Preferably the lower tear-seam or strap is adapted to break, on deployment of the air-bag, subsequent to the release of the releasable mounting means.

Advantageously the lower part of the air-bag is rolled and the upper part of the air-bag is zig-zag or concertina folded, the gas supply duct having an opening within the concertina folded section of the air-bag.

Conveniently the rolled part of the air-bag is rolled as from the front of the vehicle.

The invention also provides a method of deploying an air-bag in a motor vehicle, the air-bag having a part thereof releasably mounted to the motor vehicle, and having at least one gas flow duct extending from an inflator arrangement on the exterior of the bag to the interior of the bag through an aperture formed in the air-bag, and having a free end within the air-bag, the method comprising the steps of injecting gas into the air-bag through the gas flow duct and, subsequent to the release of the releasable mounting, moving the air-bag so that the gas flow duct is completely withdrawn from the air-bag so that the air-bag becomes totally disconnected from the rest of the vehicle.

Conveniently the air-bag is an overhead bag.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is a perspective view of an air-bag in accordance with the invention prior to folding thereof,

FIGURE 2 is a diagrammatic front view of the air-bag of Figure 1 provided for explanatory purposes, illustrating gas flows within the air-bag on deployment thereof,

FIGURE 3 is a diagrammatic sectional view taken on the line A-A of Figure 2 illustrating the bag in the stored condition before deployment,

FIGURE 4 is a view corresponding to Figure 3 illustrating the condition of the bag at an initial stage during deployment,

FIGURE 5 is a view corresponding to Figure 4 showing the bag at a subsequent stage in deployment,

FIGURE 6 is a view corresponding to Figure 5 showing the bag in a later stage of deployment,

FIGURE 7 is a view corresponding to Figure 6 illustrating the bag in a final stage of deployment, and

FIGURE 8 is a diagrammatic view of a flap valve.

Referring initially to Figure 1 of the accompanying drawings, an air-bag 1 is formed from two superimposed layers of fabric defining a rear face 2 and a front face 3. The air-bag, as illustrated, is of generally rectangular form. The air-bag 1 is an overhead air-bag, but the invention may be applied to other types of air-bag. At the uppermost edge 4 of the air-bag, a mounting tab 5 is provided. The mounting tab 5 is a tab formed of fabric which is secured to the main body of the air-bag by means of tear-seams 6. The mounting tab 5 may be engaged with a mounting arrangement such as a hook or mounting bar provided in the roof of the motor vehicle, as will become clear from the following description, to mount the air-bag 1 in position within the vehicle. The tear- seams 6 are designed so that they will break when the pressure within the air-bag passes a first threshold, that threshold preferably being in the region of 20 to 25 kPa, or in the region of 20 to 30 kPa. The mounting tab 5 is then released from the hook or bar. Thus the mounting tab 5 forms a releasable mounting for the upper part of the air-bag which becomes released in response to inflation of the air-bag.

Provided near the upper edge 4 of the air-bag 1 are two gas inlet holes 7, 8. A respective gas supply duct 9, 10 is inserted through each of the holes 7, 8. The gas supply duct extends into the interior of the air-bag, and terminates with a free end located within the interior of the air-bag. The free end is the end of the duct within the air-bag, this end of the duct not being connected to the air-bag. It is desirable for the gas ducts 9, 10 to be formed of a stiff but flexible material. The material utilised may thus be much stiffer than the material utilised for an ordinary air-bag, and indeed may be formed of material similar to that used in the fabrication of fire hoses. It is preferred that the material is such that the gas inlet ducts 9, 10 have a degree of rigidity, although the ducts should not be completely rigid but should be able to flex. Also the ducts 9, 10

should be capable of being folded so that the complete air-bag may be folded compactly to be stored in a housing.

Within a central region of the air-bag 1 the rear fabric layer 2 and the front fabric layer 3 are interconnected by stitching or strapping 11. The stitching or strapping 11 is provided so that when the air-bag is inflated the central region of the air-bag has a thickness which is determined by the length of the stitching or strapping.

The lowermost part of the air-bag is provided with a re-entrant tuck or fold 12, resembling a gusset formed by the bottom of the air-bag, which effectively forms two "wings" at the lowermost part of the air-bag, these wings being interconnected by a tear-seam 13 at the very lowest part of the air-bag. A further tear-seam 14 is provided extending parallel with the lower part of the air-bag at a position above the re-entrant tuck or fold 12. The tear-seams 13 and 14 at the lowermost part of the air-bag are designed so that they initially restrict the degree of inflation of the lower part of the air-bag. However, the tear-seams 13 and 14 are such that they will break when the pressure within the bag passes a second threshold, which is higher than the first threshold, typically being in the region of 40 to 50 kPa. The lower part of the air-bag may then inflate fully.

Referring now to Figure 2, it is intended that the gas supply ducts 9, 10 should be connected to a gas supply manifold 15 which contains or is associated with a gas generator or inflator 16. It is envisaged that, on inflation of the air-bag, initially gas will flow through the gas flow ducts 9, 10 and, because of the location of the gas flow ducts within the air-bag 1, after a preliminary stage during the inflation gas will be caused to flow downwardly past the strap area 11 towards the lowermost part of the air-bag. The

lowermost part of the air-bag will inflate to a restricted degree. Gas will then flow upwardly during the next stage of inflation of the air-bag to inflate the upper part of the air-bag. As the upper part of the air-bag inflates so the tear-seam 6 which connects the mounting tab 5 to the main part of the air-bag will break. Thus the main part of the air-bag will then no longer be connected by the connecting tab 5 to the vehicle. As will be described below in greater detail, the pressure within the air-bag will continue to rise until the second threshold is reached and the tear-seams 13, 14 in the lower part of the air-bag break, enabling the lower part of the air-bag to inflate fully whilst simultaneously the main part of the air-bag may then move downwardly, with the gas supply ducts 9 and 10 being slidably withdrawn from the air-bag until it is completely withdrawn. The free end of each duct is no longer within the air-bag. Thus, in the described embodiment, the air-bag may become totally free and totally disconnected from the rest of the vehicle. When this happens there is no physical connection between the air-bag and the vehicle.

The precise pressure at which the tear-seams 13 and 14 break may be selected in dependence upon the desired inflation characteristic of the air-bag. For example, the upper-most of these two seams, the seam 14, may break at a relatively low pressure so that the lower part of the air-bag may partially inflate to provide a certain degree of protection at a relatively early stage, the lower-most seam, seam 13, only breaking at a relatively high pressure.

Referring now to Figure 3 of the accompanying drawing, it is to be appreciated that when the air-bag 1 is mounted in position in a motor vehicle the air-bag is received within a recess or housing 20 provided within the roof 21 of a motor vehicle. The mounting tab 5 engages a hook or bar within the recess or housing 20. The lowermost part of the air-bag is rolled, and more particularly is rolled in a sense as if it was being rolled from the front of the

vehicle, to form a rolled portion 22. The uppermost part of the air-bag is zig-zag or concertina folded, to form a "concertina" section 23. The gas flow ducts 9, 10 either have their open ends within the concertina section 23 or, alternatively, have apertures in the side walls thereof which communicate with the concertina section 23.

It is to be appreciated that on actuation of the gas generator 16 within the gas supply manifold 15, gas will flow into the gas supply ducts 9 and 10. That gas will initially be injected into the concertina section 23 of the folded air-bag. The concertina section will immediately begin to expand, thus forcing the rolled section 22, still in a rolled condition, downwardly. The lowermost part of the housing 20, which is constituted by two doors 24, 25, bursts open and the rolled section 22 emerges from the roof of the vehicle to fall downwardly in front of the occupant to be protected by the air-bag as the concertina section 23 becomes inflated. After inflation of the concertina section 23 the rolled section 22 will begin to inflate, with the rolled section 22 unrolling, again as if towards the front of the vehicle. Gas then flows into the interior of the air-bag as described above with reference to Figure 2. The air-bag then reaches the condition as shown in Figure 5 in which the air-bag extends fully down from the recess or housing 20. The combination of the tear-seams 13, 14 provided at the lower part of the bag and the straps 11 ensure that the air-bag, as it moves downwardly, has a restricted "thickness" as measured axially of the vehicle. This helps ensure that the air-bag is deployed to an appropriate position in front of the occupant to be protected even if that occupant is leaning forward or "out of position".

When the rolled section 22 has become fully unrolled, pressure will begin to rise in the air-bag and when the pressure is in the region of 20 to 25 kPa or 20 to 30 kPa, the tear-seam 6 will break, thus disconnecting the

mounting tab 5 from the main part of the air-bag 1. The air-bag 1 is itself now no longer connected to the vehicle, as the gas ducts 9, 10 merely extend through holes 7, 8 into the interior of the air-bag and do not provide a firm connection. At this stage the gas supply ducts 9, 10 still extend into the interior of the air-bag 1, but the gas ducts are only inserted through apertures in the air-bag 1, and so the air-bag 1 can move away from the housing 20 while the gas ducts 9, 10 are being withdrawn from the air-bag.

The pressure within the air-bag will rise, until a pressure in the region of 40 to 50 kPa is achieved, when the tear-seams 13, 14 in the lower part of the air-bag will break. The lower part of the air-bag then fully inflates.

In a modified embodiment the seam 14 may break at a pressure within the range of 15 to 30 kPa, so that the lower part of the air-bag may inflate at an early stage.

As an occupant 26 to be protected by the air-bag moves forwardly and impinges with the air-bag, the occupant may impart a generally forward and generally downward force to the air-bag. If a generally downward force is applied to the air-bag the entire air-bag is free to move downwardly, with the gas supply ducts being completely withdrawn from the air-bag. Thus, as shown in Figure 7, the air-bag 1 may become totally disconnected from the rest of the vehicle. The air-bag will, of course, be located between the occupant of the vehicle and the structure of the vehicle located in front of that occupant. The structure may be the steering wheel, if the occupant is the driver, or the dashboard if the occupant is a front seat passenger. Alternatively, the structure may be the front seats of the vehicle if the occupant is a rear seat occupant.

The inflated air-bag forms a "cushion" between the occupant and the structure of the vehicle in front of the occupant. The apertures 7 and 8, from which the gas supply ducts 9 and 10 have been withdrawn, act as venting apertures although, if desired, non return or "flap" valves 27 as shown in Figure 8 may be provided within the air-bag which serve to seal, or at least reduce the flow of gas through, these apertures once the gas supply ducts 9 and 10 have been withdrawn from them. The flap valve 27 shown in Figure 8 is associated with the aperture 9. The flap is secured to the fabric of the air-bag 1 adjacent the aperture 9 and is configured so that when the gas duct 9 is withdrawn from the air-bag the flap valve 27 will move to a position in which it at least substantially seals the aperture 7.

In a preferred embodiment of the invention, the gas generator 16 may be adapted such that during the initial stage of deployment, during which the concertina section 23 is being inflated, the gas generator only provides a relatively low flow rate of gas, and during the subsequent stage of inflation, when the rolled region is being unrolled and inflated, a much higher flow of gas is provided. This may be achieved by using two gas generators which are actuated sequentially, the first gas generator being a relatively "gentle" gas generator and a second gas generator, which is actuated a predetermined period of time after actuation of the first gas generator, being more aggressive.

Whilst the invention has been described with reference to an embodiment in which there is a single gas generator 16 and a gas supply manifold 15 supplying gas to the two gas supply ducts, a separate gas generating arrangement may be provided for each gas supply duct. In a further modified embodiment of the invention there is only one gas supply duct.

In certain embodiments the lower tear-seams 13, 14 may be replaced by internal tear straps which limit the initial degree of inflation of the lower part of the air-bag and which break when a predetermined internal pressure is achieved.

Whilst, in the described embodiment of the invention, the air-bag is mounted to the motor vehicle by means of a mounting tab 5 associated with a tear-seam 6 which is adapted to break when a predetermined pressure is present within the interior of the air-bag, alternative mounting arrangements may be utilised. It is preferred that the mounting arrangement is such that the mounting arrangement becomes released in response to inflation of the air-bag, but an alternative form of releasable mounting may be utilised in which the releasable mounting releases the upper part of the air-bag in response to a forward and/or downward force applied to the air-bag, for example the type of force caused when the occupant of the vehicle physically strikes the air-bag on moving forwardly, particularly if the occupant of the vehicle is not restrained by a seat-belt.

Thus, in one embodiment of the invention, the releasable mounting may release the upper part of the air-bag in response to a predetermined type of impact delivered to the air-bag by the occupant to be protected by the air-bag.

In the present Specification "comprises" means "includes or consists of" and "comprising" means "including or consisting of".

CLAIMS:

1. An air-bag in a motor vehicle, the air-bag being releasably mounted to the vehicle by means of releasable mounting means which initially connect part of the air-bag to the vehicle but which, in predetermined circumstances, are released so that the air-bag is disconnected from the vehicle, the air-bag being associated with an inflator arrangement, there being at least one gas flow duct for gas from the inflator arrangement, the gas flow duct extending from the exterior of the air-bag to the interior of the air-bag through an aperture formed in the air-bag, and having a free end within the air-bag, the duct being adapted to be completely withdrawn from the air-bag in response to a movement of the air-bag after the releasable mounting means have disconnected the air-bag from the vehicle so that the air-bag becomes totally disconnected from the vehicle.

2. An air-bag according to Claim 1 wherein the aperture is provided with a valve to at least partially seal the aperture when the duct is withdrawn from the air-bag.

3. An air-bag according to any one of the preceding Claims wherein a central part of the air-bag is provided with stitching or strapping in order to minimise the dimension of that part of the air-bag on inflation thereof.

4. An air-bag according to any one of the preceding Claims wherein the inflator arrangement is adapted to provide a relatively low flow rate of gas during an initial stage of inflation of the air-bag, and a higher flow rate of gas during a subsequent stage of inflation of the air-bag.

5. An air-bag according to any one of the preceding Claims wherein the releasable mounting means are adapted to be released in response to inflation of the air-bag.

6. An air-bag according to Claim 9 wherein the releasable mounting means are adapted to be released when a predetermined pressure is present within the air-bag.

7. An air-bag according to any one of the preceding Claims wherein the air-bag is an overhead bag.

8. An air-bag according to Claim 7 wherein part of the air-bag which is to form the lower-most part of the air-bag on deployment thereof is provided with at least one lower tear-seam or strap adapted to initially restrict the degree of inflation of the lower part of the air-bag, and adapted to break during inflation of the air-bag.

9. An air-bag according to Claim 8 wherein the lower tear-seam or strap is adapted to break, on deployment of the air-bag, subsequent to the release of the releasable mounting means.

10. An air-bag according to any one of Claims 7 to 9 wherein the lower part of the air-bag is rolled and the upper part of the air-bag is zig-zag or concertina folded, the gas supply duct having an opening within the concertina folded section of the air-bag.

11. An air-bag according to Claim 10 wherein the rolled part of the air-bag is rolled as from the front of the vehicle.

12. A method of deploying an air-bag in a motor vehicle, the air-bag having a part thereof releasably mounted to the motor vehicle, and having at least one gas flow duct extending from an inflator arrangement on the exterior of the bag to the interior of the bag through an aperture formed in the air-bag, and having a free end within the air-bag, the method comprising the steps of injecting gas into the air-bag through the gas flow duct and, subsequent to the release of the releasable mounting element, moving the air-bag so that the gas flow duct is withdrawn from the air-bag so that the air-bag becomes totally disconnected from the rest of the vehicle.

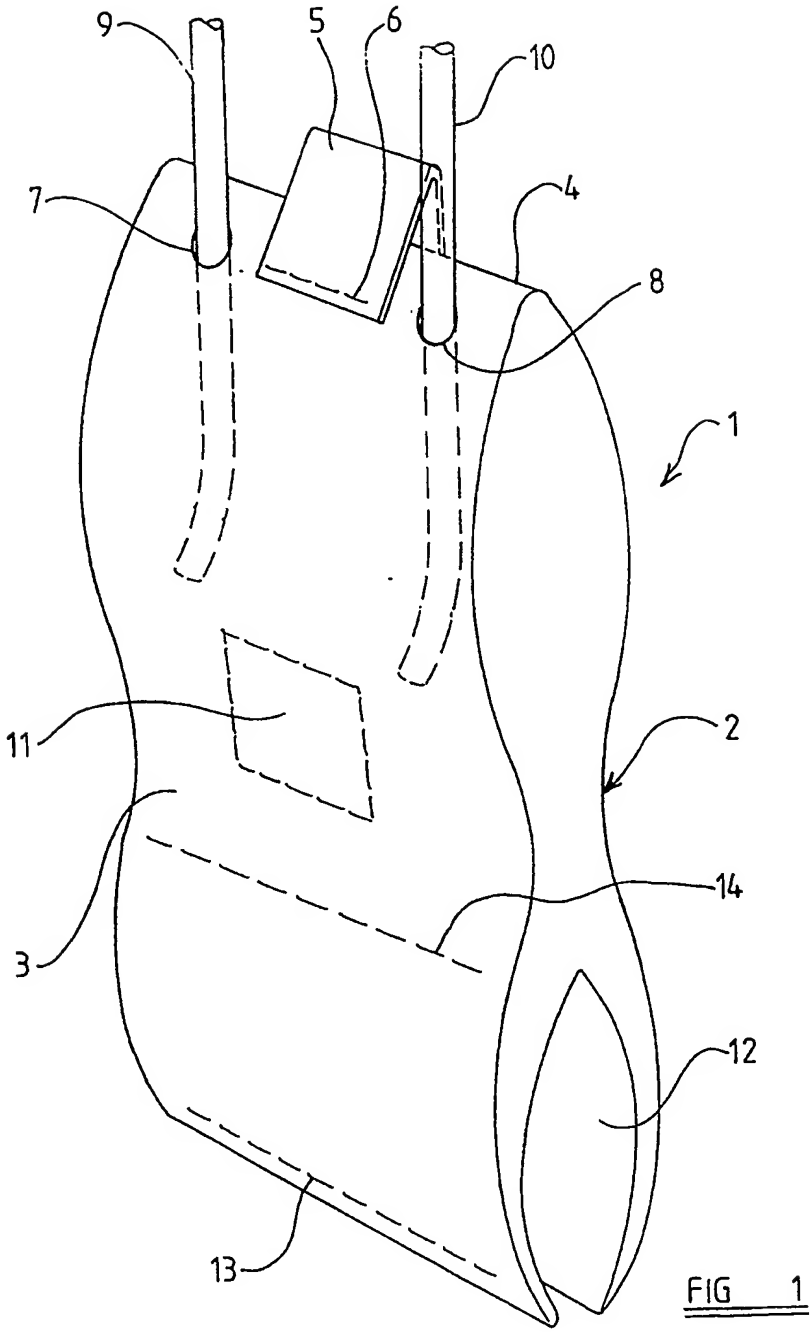


FIG 1

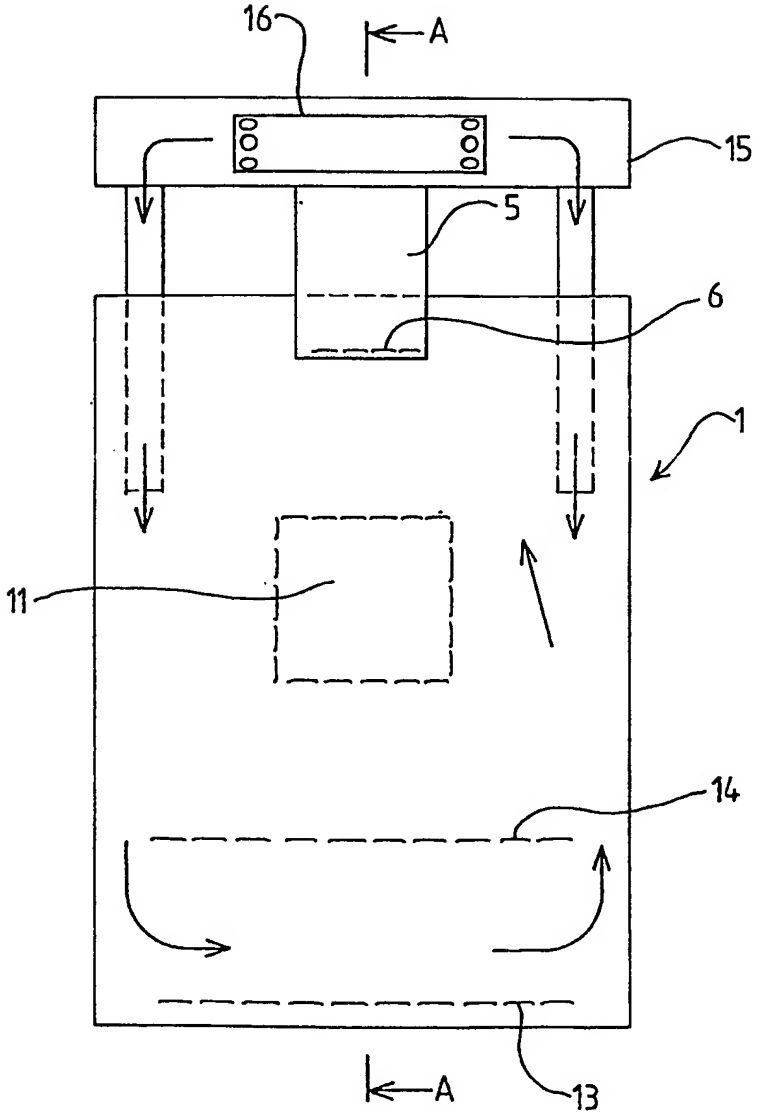


FIG 2

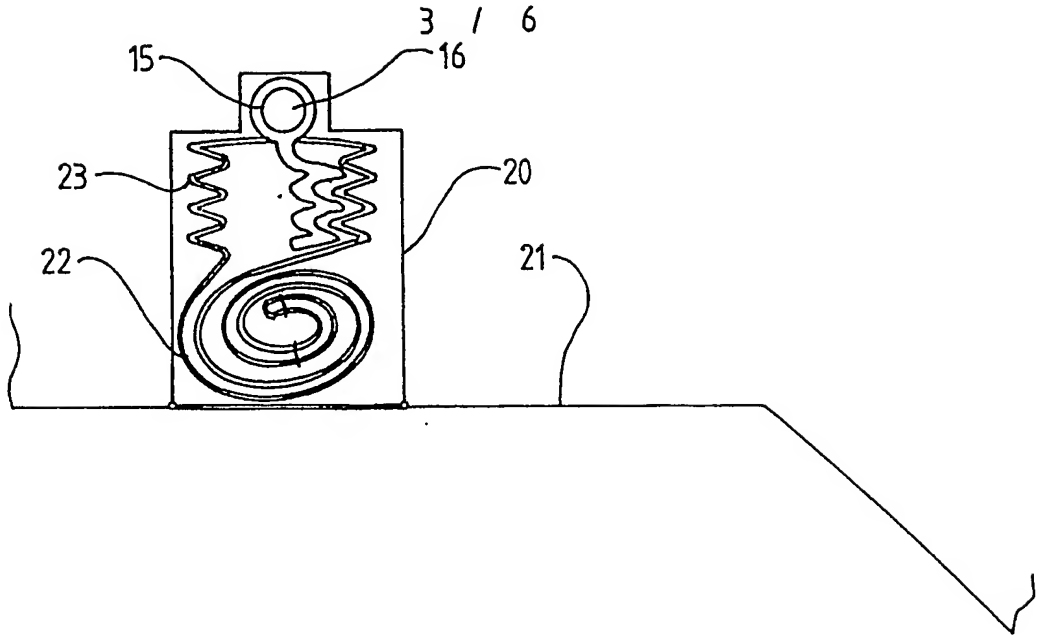


FIG 3

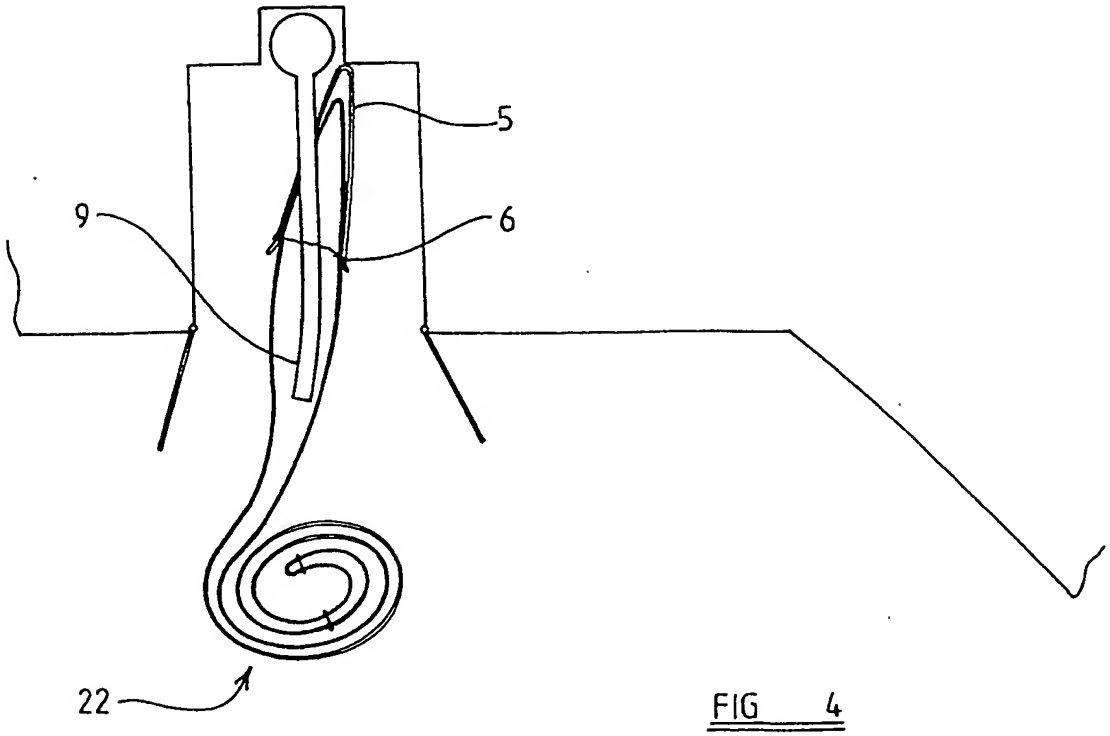


FIG 4

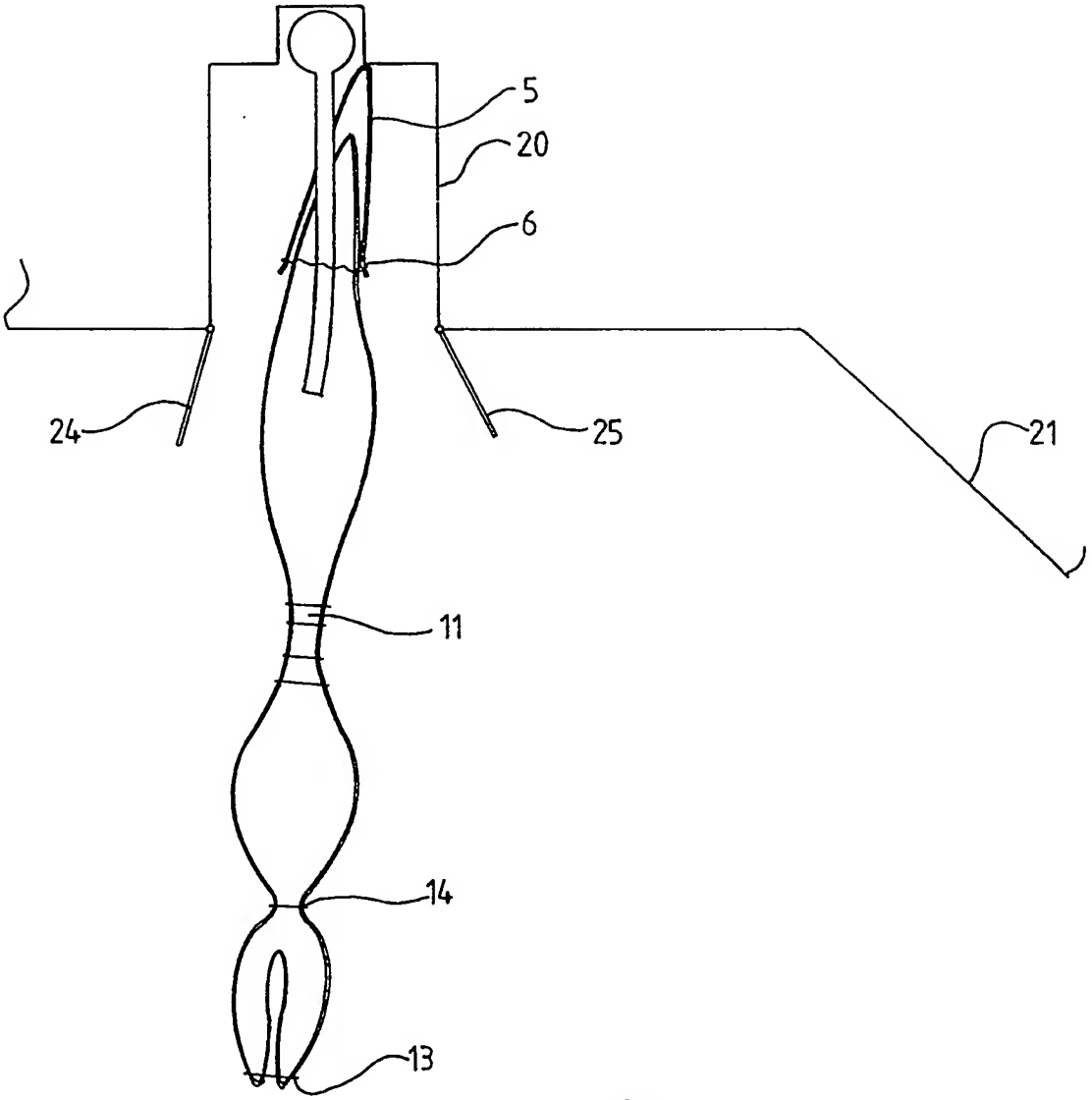


FIG 5

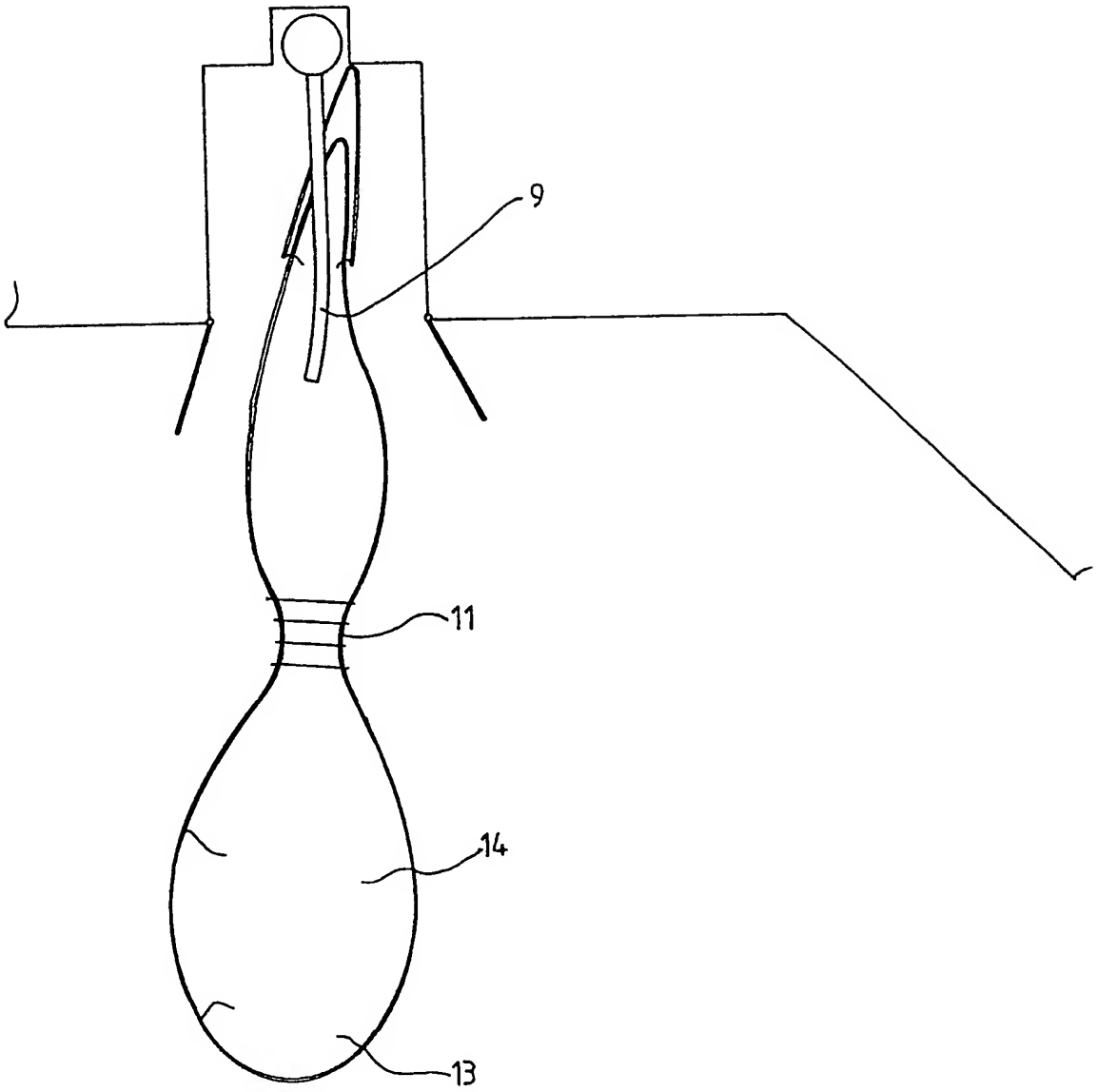
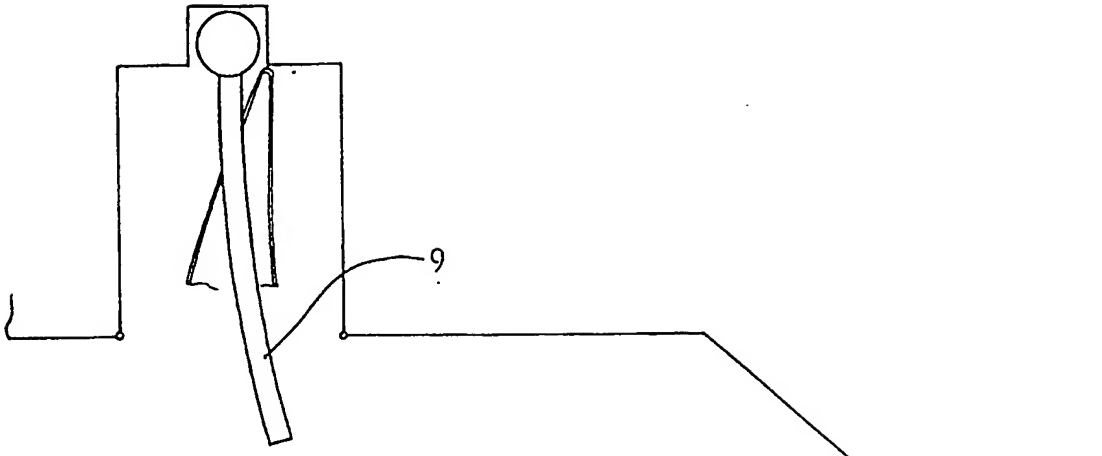


FIG 6



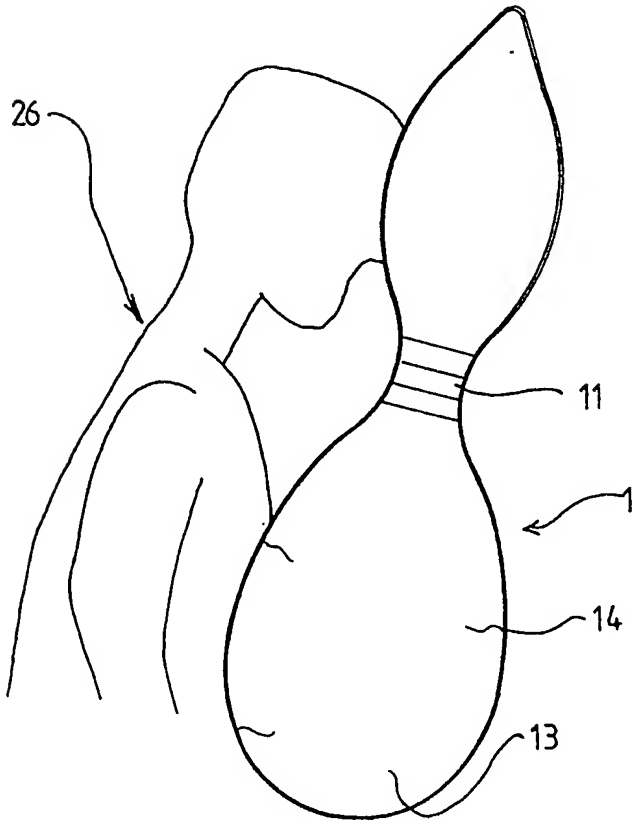


FIG 7

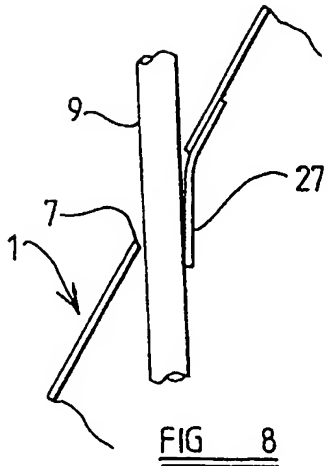


FIG 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 03/00626

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B60R 21/16, B60R 21/22
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5366241 A (P.W. KITHIL), 22 November 1994 (22.11.94), column 8, line 43 - column 9, line 7	1,5,7,12
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A	DE 19757410 A1 (PETRI AG), 24 June 1999 (24.06.99)	1-12
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
10 July 2003	14 -07- 2003
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Hans Nordström / MRo Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 03/00626

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No.
PCT/SE 03/00626

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